Futo Journal Series (FUTOJNLS)
e-ISSN : 2476-8456 p-ISSN : 2467-8325
Volume-3, Issue-1, pp- 13 - 26
www.futojnls.org

Research Paper July 2017

Effect of Humanure and Rumen Digesta on Soil Physico-Chemical Properties and the Yield of Cucumber in Imo South-Eastern, Nigeria

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Abstract

An experiment was set up in the 2015 cropping seasons to compare the effect of humanure and rumen digesta on soil physico-chemical properties and the yield of cucumber in Imo Southeast, Nigeria. The study was conducted at the Teaching and Research Farm of the School of Agriculture and Agricultural Technology, Federal University of Technology, Owerri. The treatments were made up of T1- Control = 0 kg/ha; T2 - Humanure = 10 t/ha; T3 - Rumen digesta = 10t/ha; T4 - Humanure + Rumen digesta = (5 + 5 t/ha) and T5 - Humanure + Rumen digesta = (10 + 10 t/ha). The experiment was laid out in randomized complete block design (RCBD) and raw data were analyzed using Analysis of Variance (ANOVA) at p=0.05 probability level. Significant differences were separated using F-LSD. The results obtained showed that both humanure and rumen digesta significantly improved the soil bulk density, total porosity and moisture content relative to the control except the aggregate stability and textural properties of the soil. Also the soil chemical properties improved significantly when the treatments were compared with the control and when the treatments were compared with one another. The cucumber yield followed the same improvement trend. Humanure and rumen digesta combination has proved to be superior in soil nutrient enrichment for organic cucumber production in this ultisol.

Keywords: Humanure, Rumen, Heavy, Metal, Growth, Cucumber

1. Introduction

Wastes add to the pool of organic matter contents of tropical soils which have been reported to be a major limiting factor against the yield of crop in this area (Mbah*et al.,* 2007; Onweremmadu *et al.,* 2008).It is known that continuous cropping on a piece of land without adequate use of soil enrichment materials lowers soil fertility and subsequent reduction in crop yield (Agboola and Odeyemi, 1972). In the past, soil fertility was maintained in the Southeastern Nigeria via prolonged bush fallow (5 – 20 years) (Unamma

et al. 1985). However, increase in population has resulted to reduced fallow periods in certain areas, leading to poor crop yield.

The application of organic fertilizers should be considered, including the use of humanure. The opportunity exists to improve agricultural production by subsistence farmers through the production of fertilizers and soil conditioner from human excreta (humanure). Humanure is human excrement (faeces and urine) that is recycled for agricultural uses. Human urine is an excellent soil fertilizer that is rich in nitrogen (N), while faeces are rich in phosphorus (P) and potassium (K) (Jönsson *et al.,* 2004). Although nutrient content in faecal material is lower than that of urine, it can act as a valuable soil conditioner (Jönsson *et al.,* 2004). The use of humanure can result in improved agricultural production of subsistence crops, which would improve food security through increased food availability and improved access to food through own production. Rumen digesta are waste from abattoirs gotten from cattle, sheep and goat that are presently a menace in most urban cities in developing countries (Ekpe *et al.,* 2014). The digesta is made up of undigested fibrous materials e.g. grasses that are still in their early stages of digestion. The digesta in the rumen is not uniform but rather is stratified into gas, liquid and particles of different sizes, densities and other physical characteristics. The rumen digesta is acted upon by a good number of microbes which include: Bacteria, protozoa, fungi, archaic, and viruses and by mass account for 40-60% of total microbial matter in rumen (Awodum, 2008).

Cucumber is an ancient vegetable and one of the most improvement members of the cucurbitaceae family (Lower and Edwards, 1986; Thao, 1998). It is thought to be one of the oldest vegetables cultivated by man with historical records dating back 5,000 years (Wehner and Guner, 2004). The crop is the fourth most important vegetable after tomato, cabbage and onion in Asia, the second most important vegetable crop after tomato in Western Europe with growing acceptance in southeastern Nigeria. It was due to this increasing popularity of cucumber among the Igbo communities in Nigeria that it was chosen as a test crop in an experiment involving the assessment of the effect of humanure and rumen digesta on soil physico-chemical properties and the yield of cucumber in Imo South-East, Nigeria.

2. Materials and Method

2.1. Site description

The study was carried out at in Ihiagwa, Imo State, Southeastern, Nigeria. Ihiagwa is located in the humid tropics at latitude 5˚24˚N and longitude 7˚01˚E. The towns annual rainfall and temperature range from 2500 - 3000m and 25 - 30˚C respectively. The soils of Ihiagwa are derived from the coastal plain sands.

2.2. Experimental Materials and Treatment Combination

Seeds were bought at Agricultural Development Program (ADP), Owerri, Imo State, Nigeria. 5 bags of rumen digesta were obtained from abattoir at Relief Market, Imo State, Nigeria and 5 bags of humanure were from the sewage dumping ground at Onitsha expressway, Irete, Imo State. The treatments comprised of T1- Control at 0 kg/ha; T2– Humanure at 10 t/ha; T3 - Rumen digesta at 10t/ha; T4 - Humanure + Rumen digesta at (5 + 5 t/ha) and T5 - Humanure + Rumen digesta at (10 + 10 t/ha).

2.3. Experimental Design and Field Layout

There were 20 plots in the experimental field. Each plot measured 3 x 3 m. There was 1m alley between blocks and between plots. The experiment was laid out in a randomized complete block design with 5 treatments replicated 4 times. The diagrammatic representation of the field layout is shown in Figure 1.

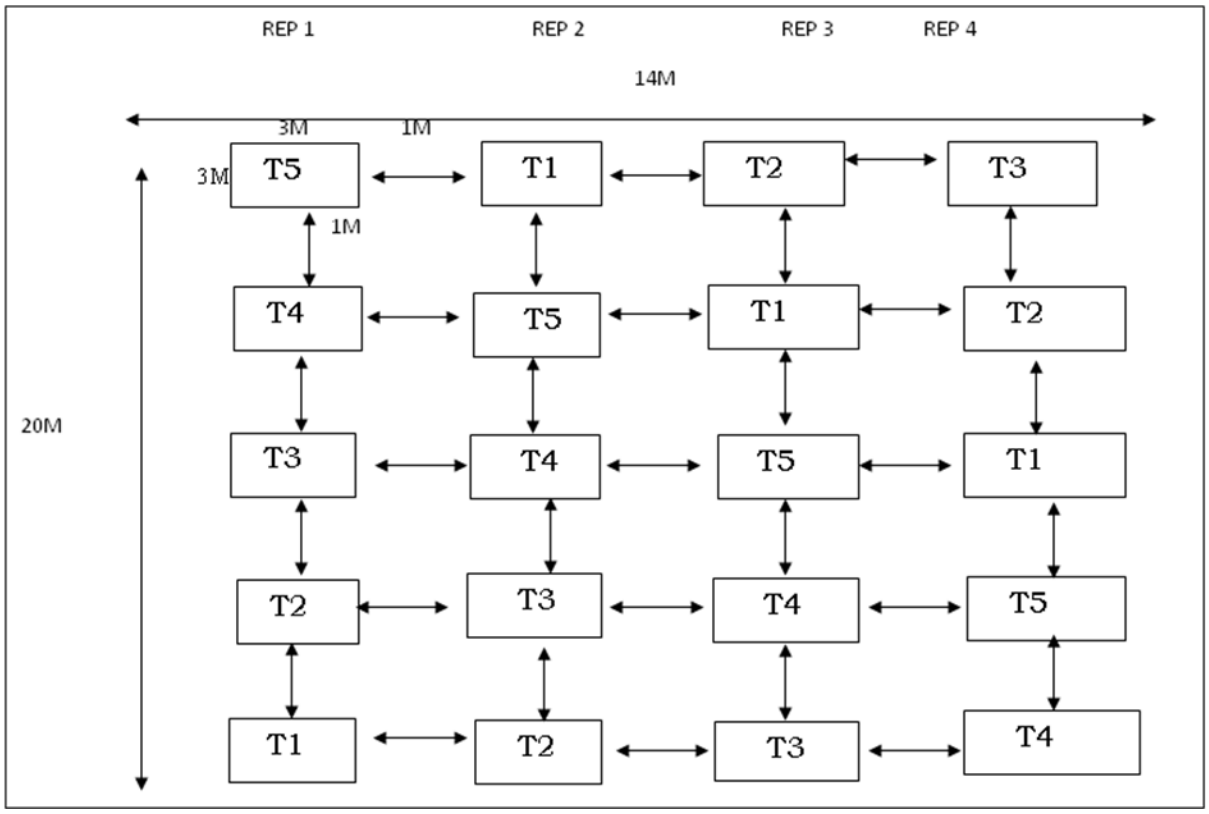

Fig. 1: Treatment allocation in a Randomized Complete Block Design.

2.4. Soil Sampling and Laboratory Analysis

The initial and post-harvest soil samples were collected at 0 – 30 cm soil depth. The core sampler attached to a soil auger was used in the soil sampling and these samples were used for the determination of soil physical and chemical properties. The samples in the core samplers first used for the determination of soil physical properties and later air dried, crushed and sieved using 2mm size sieve in preparation for use in determination of soil chemical properties. Bulk density was determined using core method (Blake and Hartge, 1986) equation 1. Particle size distribution was determined by hydrometer method in water and Calgon (Bouyocous, 1951). Soil texture was determined by matching the value of the particle size against the textural triangle. Moisture content was determined by gravimetric method.

$$\text{Bulk Density} = \frac{Weight\ of\ Wet\ Soil - Weight\ of\ Dry\ Soil}{Weight\ of Wet\ Soil} X \frac{100}{1} \quad (1)$$

Total Porosity was calculated from the results of bulk density and particle density using

$$\text{Tp = 1- Pb/Ps x 100} \quad \text{Tp} = 1 - \frac{Pb}{Ps} x100 \quad (2)$$

where; Pb = bulk density (g/cm3), Ps = particle density (2.65 g/cm^3).

The soil pH was determined using 1: 2 – 5 soil liquid (both in water and potassium chloride), (Maclean 1982). Organic carbon and organic matter: Organic carbon was determined using the Walkey and Black method (Nelson and Sommers, 1982). The organic matter was obtained by multiplying the percentage organic carbon by Van Bemmele as wet digestion method (1.724). Exchangeable bases K, Na were extracted using 1N ammonium acetate buffered at pH 7.0 (Chapman, 1965). K, Na were determined using flame photometer (Jackson, 1970) while Ca and Mg were determined using ethylene thiamine tetra acid (EDTA) complex metric titration. Available phosphorus was determined using Bray 2 method (Olsten and Sommers, 1982). Exchangeable acids H and Al were determined by 0.1 NKCL extraction methods (Maclean, 1982). The H and Al were separated using 0.5 NHCL. Total nitrogen was determined using modified micro kjeldahl method according to the procedures of Bremner (1982). Effective cation exchange capacity was determined by summation of total exchangeable bases (TEB) and exchangeable acids (Brady and Weils, 2002).

2.5. Cultural Practices

The land was manually cleared using machetes and stumps were removed after which seed beds were made using hoe and spade. The treatments were incorporated into the soil and allowed to stand for 2 weeks before seed placement. Cucumber seeds were planted by direct seeding 2 weeks after the incorporation of the treatments. The planting was done at the spacing of 50 x 50cm to give a plant population of 40,000 plants per hectare. Cucumber variety ASHLEY was used and three seeds were planted per hole and later thinned down 1 seedling per stand 2 weeks after planting. Weeds were controlled manually using hoe and by hand picking to keep the plot free of weeds as regularly as the need arose.

2.6. Measurement of Fruit Yield

The total weight of fruits harvested per plot in the net plot was summed up to get the total fruit yield.

2.7 Statistical Analysis

Generated soil data were analyzed using Analysis of Variance (ANOVA). Significant means were separated using Fishers Least Significant Difference (F-LSD) at 5% level of probability.

3.0. Results and Discussion

3.1. Initial Soil Properties

The result of the initial soil properties before the treatments were applied is presented in table 1.

Table 1: Pre-Planting Soil Properties of the Experimental Site

Property	Soil	Rating
pH (H_20)	5.42	
pH (Kcl)	5.01	
Organic carbon (%)	1.02	
Total Nitrogen (%)	1.11	
Phosphorus (Mg.100g^{-1})	11.6	
Available Ca (Cmol.kg^{-1})	1.08	
Available Mg (Cmol.kg^{-1})	1.02	
Available K (Cmol.kg^{-1})	0.39	
Exchangeable Na (Cmol.kg^{-1})	0.06	
Exchangeable Al^{3+} (Cmol.kg^{-1})	0.87	
Hydrogen ion	0.21	
Total exchangeable acidity	1.08	
Total exchangeable bases	2.55	
Effective cation exchange capacity	3.63	
Percentage base saturation (%)	70.30	
Bulk density(g.Cm-^{3})	1.50	
Total porosity (%)	43.18	
Moisture content(g.Cm-^{3})	14.28	
Sand (%)	87.96	
Silt (%)	4.28	
Clay (%)	7.76	
Textural class	S	

3.1.1. Effects of Treatments on Soil Physical Properties

The effects of humanure, rumen digesta and humanure and rumen digesta combinations on soil physical properties are presented in Table 2.

Table 2: Effects of Treatments on Soil Physical Properties

Treatment	AS	Bd(g/cm^3)	TP (%)	MC(g/kg)	Sand (%)	Silt (%)	Clay (%)
Control	42.93	1.44^a	45.68^a	12.20^a	84.6	4.4	11.00
H at 10t/ha	43.25	1.41^b	46.79^b	14.10^b	83.6	4.4	12.00
RD at 10t/ha	43.8	1.40^c	46.98^c	14.12^c	83.6	4.4	12.00
H and RD at 5+5t/ha	43.90	1.39^d	47.37^d	15.29^d	83.6	4.4	12.00
H and RD at 10+10t/ha	46.57	1.33^e	49.81^e	18.06^e	82.6	4.4	13.00
F-LSD(0.05)	NS	0.02	0.04	0.21	NS	NS	NS

Note: Figures with the same super scripts are not statistically significant while figures with different super script are significant.

3.1.2. Bulk Density

The result showed that there was significant difference when control was compared with the treatments and when the treatments were compared with one another. The sole humanure

application produced 0.03 when compared with control while the sole rumen digesta and humanure and rumen digesta combinations produced 0.04, 0.05, and 0.11, respectively. The sole humanure application when compared with humanure and rumen digesta combinations produced 0.02 and 0.08, respectively. The sole rumen digesta application produced 0.07 when compared with humanure and rumen digesta combination of 10 + 10 t/ha. The humanure and rumen digesta combinations of 5 + 5 and 10 + 10t/ha produced 0.06 when compared with one another. However, there was no significant difference when the sole humanure application was compared with the sole rumen digesta application and also when the sole rumen digesta application was compared with humanure and rumen digesta combination of 10+ 10 t/ha.

3.1.3. Total Porosity

The result showed that there was significant difference when control was compared with the treatments and when the treatments were compared with one another. When control was compared with the sole humanure application, the sole rumen digesta application and humanure and rumen digesta combinations they produced 1.11, 1.3, 1.69 and 4.13 respectively. The sole humanure when compared with the sole rumen digesta and humanure and rumen digesta combinations produced 0.19, 0.58 and 3.02. The humanure and rumen digesta combinations were compared with the sole rumen digesta application and produced 0.39 and 2.83 respectively. The humanure and rumen digesta combinations of 5 + 5 and 10 + 10 t/ha when compared produced 2.44.

3.1.4. Moisture Content

The result showed that there was significant difference when control was compared with the treatments and when the treatments were compared with one another. The sole humanure application produced 1.9 when compared with control while the sole rumen digesta and humanure and rumen digesta combinations produced 1.92, 3.09, and 5.82 respectively. The sole humanure application when compared with humanure and rumen digesta combinations produced 1.19 and 3.96 respectively. The sole rumen digesta application produced 1.17 and 3.94 when compared with humanure and rumen digesta combinations. The humanure and rumen digesta combinations of 5 + 5 and 10 + 10 t/ha produced 2.77 when compared with one another. However, there was no significant difference when the sole humanure application was compared with the sole rumen digesta application.

3.2. Effect of Treatments on Soil Chemical Properties

The effects of humanure, rumen digesta and humanure and rumen digesta combinations on soil chemical properties are presented in the Table 3.

3.2.1. pH_w

The result showed that there was significant difference when control was compared with the treatments and when the treatments were compared with one another. When control was compared with the sole humanure application, the sole rumen digesta application and humanure and rumen digesta combinations they produced 0.8, 0.6, 0.9 and 7.9 respectively. The sole humanure when compared with the sole rumen digesta and humanure and rumen digesta combinations produced 0.2, 0.1 and 7.2.

The humanure and rumen digesta combinations were compared with the sole rumen digesta application and produced 0.3 and 7.4. The humanure and rumen digesta combinations of 5 + 5 and 10 + 10t/ha when compared produced 7.1. This shows that there is an increase in the pH (water) level of the soil with the addition of rumen digesta and humanure. The improvement in the soil pH observed in the amended plots confirmed the liming effect of agro-wastes similarly reported by Okonkwo *et al.,* (2009), Duruigbo *et al.,* (2006), Ano and Ubochi (2007) and Chukwu (2001).

3.2.2. $pH_{(kcl)}$

The result showed that there was significant difference when control was compared with the treatments and when the treatments were compared with one another. The sole humanure application produced 0.9 when compared with control while the sole rumen digesta and humanure and rumen digesta combinations produced 0.8, 0.9 and 1.9 respectively. When the sole rumen digesta application and humanure and rumen digesta combination of 10 + 10 t/ha were compared with the sole humanure application they produced 0.1 and 1 respectively. The sole rumen digesta application produced 0.1 and 1.1 when compared with humanure and rumen digesta combinations. The humanure and rumen digesta combinations of 5 + 5 and 10 + 10 t/ha produced 1 when compared with one another. However, there was no significant difference when the sole humanure application was compared with the humanure and rumen digesta combination of 5 + 5 t/ha. This shows that with the addition of humanure and rumen digesta in the soil there is an increase in the pH (salt) level of the soil. The improvement in the soil pH observed in the amended plots confirmed the liming effect of agro-wastes similarly reported by Okonkwo *et al.,* (2009), Duruigbo *et al.,* (2006), Anon and Ubochi (2007) and Chukwu, (2001).

3.2.3. Potassium (K)

The result showed that there was significant difference when control was compared with the treatments and when the treatments were compared with one another. The sole humanure application produced 0.129 Cmol/100g soil of potassium when compared with control while the sole rumen digesta and humanure and rumen digesta combinations produced 0.121, 0.13, and 0.126 Cmol/100g soil of K respectively. The sole humanure application produced 0.087Cmol/100g soil of K when compared with humanure and rumen digesta combination of 10 + 10 t/ha. The sole rumen digesta application produced 0.095 Cmol/100g soil of K when compared with humanure and rumen digesta combination of 10 + 10 t/ha. The humanure and rumen digesta combinations of 5 + 5 and 10 + 10 t/ha produced 0.086 Cmol/100g soil of K when compared with one another. Nevertheless, there was no significant difference when the sole humanure application was compared with the sole rumen digesta application and humanure and rumen digesta combination of 5 + 5 t/ha and also when the sole rumen digesta application was compared with humanure and rumen digesta combination of 5 + 5 t/ha.

3.2.4. Sodium (Na)

The result showed that there was significant difference when control was compared with the treatments and when the treatments were compared with one another. The sole humanure application produced 0.039 Cmol/100g soil of Na when compared with control while the sole rumen digesta and humanure and rumen digesta combinations produced 0.034, 0.043 and

0.064 Cmol/100g soil of Na respectively. The sole humanure application produced 0.025 Cmol/100g soil of Na when compared with humanure and rumen digesta combination of 10 + 10 t/ha. The sole rumen digesta application produced 0.03 Cmol/100g soil of Na when compared with humanure and rumen digesta combination of 10 + 10 t/ha. The humanure and rumen digesta combinations of 5 + 5 and 10 + 10 t/ha produced 0.021 Cmol/100g soil of Na when compared with one another. Nevertheless, there was no significant difference when the sole humanure application was compared with the sole rumen digesta application and humanure and rumen digesta combination of 5 + 5 t/ha and also when the sole rumen digesta application was compared with humanure and rumen digesta combination of 5 + 5 t/ha. This shows that with the addition of humanure and rumen digesta in the soil there is an increase in the sodium content in the soil.

3.2.5. Phosphorus (P)

The result showed that there was significant difference when control was compared with the treatments and when the treatments were compared with one another. When control was compared with the sole humanure application, the sole rumen digesta application and humanure and rumen digesta combinations they produced 8, 6, 7.3 and 20.3 ppm/100g soil of P respectively. The sole humanure when compared with the sole rumen digesta and humanure and rumen digesta combinations produced 1.4, 0.7, and 12.3 ppm/100g soil of P. The humanure and rumen digesta combinations were compared with the sole rumen digesta application and produced 0.7 and 13.7 ppm/100g soil of P respectively. The humanure and rumen digesta combinations of 5 + 5 and 10 + 10 t/ha when compared produced 13 ppm/100g soil of P. This shows that there is an increase in the phosphorus content of the soil with the addition of rumen digesta and humanure. Awodum, (2008) reported that soils treated with rumen digesta have higher phosphorus content.

3.2.6. Nitrogen (N)

The result showed that there was significant difference when control was compared with the treatments and when the treatments were compared with one another. When control was compared with the sole humanure application, the sole rumen digesta application and humanure and rumen digesta combinations they produced 0.063, 0.061, 0.064 and 0.081/100 g soil of N respectively. The sole humanure when compared with the sole rumen digesta and humanure and rumen digesta combinations produced 0.002, 0.001, and 0.018/100 g soil of N. The humanure and rumen digesta combinations were compared with the sole rumen digesta application and produced 0.003 and 0.02/100 g soil of N respectively. The humanure and rumen digesta combinations of 5 + 5 and 10 + 10 t/ha when compared produced 0.017/100 g soil of N. This shows that there is an increase in the nitrogen content of the soil with the addition of rumen digesta and humanure. This agrees with the findings of Awodum, (2008) and Okonkwo *et al.,* (2009) who noted that mineralization of organic wastes result in the release of organic bound nutrients in the soil notably N.P.K and organic matter.

3.2.6. Calcium (Ca)

The result showed that there was significant difference when control was compared with the treatments and when the treatments were compared with one another. The sole humanure application produced 2.8 Cmol/100g soil of Ca when compared with control while the sole rumen digesta and humanure and rumen digesta combinations produced 2.45, 3.08, and

4.35 Cmol/100g soil of Ca respectively. When the sole rumen digesta application and humanure and rumen digesta combination of 10 + 10t/ha were compared with the sole humanure application they produced 0.35 and 1.55 Cmol/100g soil of Ca respectively. The sole rumen digesta application produced 0.6 and 1.9 Cmol/100g soil of Ca when compared with humanure and rumen digesta combinations. The humanure and rumen digesta combinations of 5 + 5 and 10 + 10 t/ha produced 1.3 Cmol/100g soil of Ca when compared with one another. However, there was no significant difference when the sole humanure application was compared with the humanure and rumen digesta combination of 5 + 5 t/ha.

3.2.7. Magnesium (Mg)

The result showed that there was significant difference when control was compared with the treatments and when the treatments were compared with one another. The sole humanure application produced 2.3 Cmol/100g soil of Mg when compared with control while the sole rumen digesta and humanure and rumen digesta combinations produced 1.8, 2.4, and 3.6 Cmol/100g soil of Mg respectively. When the sole rumen digesta application and humanure and rumen digesta combination of 10 + 10 t/ha were compared with the sole humanure application they produced 0.5 and 1.3 Cmol/100g soil of Mg respectively. The sole rumen digesta application produced 0.6 and 1.8 Cmol/100g soil of Mg when compared with humanure and rumen digesta combinations. The humanure and rumen digesta combinations of 5 + 5 and 10 + 10 t/ha produced 1.2 Cmol/100g soil of Mg when compared with one another. However, there was no significant difference when the sole humanure application was compared with the humanure and rumen digesta combination of 5 + 5 t/ha. This shows that with the addition of humanure and rumen digesta in the soil there is an increase in the magnesium content in the soil. The increase in values may be as a result of increase in soil pH which invariably has liming effect on the soil and agrees with NRCS, (1998) which noted that increase in soil pH increases the availability of exchangeable bases. Increases in exchangeable bases due to application of organic residues have been reported by Mbagwu (1992).

3.2.8. Organic Matter (OM)

The result showed that there was significant difference when control was compared with the treatments and when the treatments were compared with one another. The sole humanure application produced 1.33/100 g of OM when compared with control while the sole rumen digesta and humanure and rumen digesta combinations produced 1.28, 1.34, and 1.95/100 g soil of OM respectively. When the sole rumen digesta application and humanure and rumen digesta combination of 10 + 10 t/ha were compared with the sole humanure application they produced 0.05 and 0.62/100 g soil of OM respectively. The sole rumen digesta application produced 0.06 and 0.67/100 g soil of OM when compared with humanure and rumen digesta combinations. The humanure and rumen digesta combinations of 5 = 5 and 10 + 10 t/ha produced 0.61/100 g soil of OM when compared with one another. However, there was no significant difference when the sole humanure application was compared with the humanure and rumen digesta combination of 5 + 5 t/ha. This shows that with the addition of humanure and rumen digesta in the soil there is an increase in the organic matter content of the soil. This result obtained may be as a result of increased organic carbon and mineralization of the fresh rumen digesta. This is consistent with the findings of NRCS (1996) which noted that applying animal manure increase the supply of organic matter in the soil.

3.2.9. Organic Carbon (OC)

The result showed that there was significant difference when control was compared with the treatments and when the treatments were compared with one another. When control was compared with the sole humanure application, the sole rumen digesta application and humanure and rumen digesta combinations they produced 0.76, 0.74, 0.77 and 1.12/100 g soil of OC respectively. The sole humanure when compared with the sole rumen digesta and humanure and rumen digesta combinations produced 0.02, 0.01 and 0.36/100 g soil of OC. The humanure and rumen digesta combinations were compared with the sole rumen digesta application and produced 0.03 and 0.38/100 g soil of ON respectively. The humanure and rumen digesta combinations of 5 + 5 and 10 + 10 t/ha when compared produced 0.35/100 g soil of OC.

3.2.10. Exchangeable Acidity (EA)

The result showed that there was significant difference when control was compared with the treatments and when the treatments were compared with one another. When control was compared with the sole humanure application, the sole rumen digesta application and humanure and rumen digesta combinations they produced 0.7, 0.64, 0.74, and 1.28 Cmol/100g soil of EA respectively. The sole humanure when compared with the sole rumen digesta and humanure and rumen digesta combinations produced 0.06, 0.04, and 0.58 Cmol/100g soil of EA. The humanure and rumen digesta combinations were compared with the sole rumen digesta application and produced 0.1 and 0.64/100 g soil of EA respectively. The humanure and rumen digesta combinations of 5 + 5 and 10 + 10 t/ha when compared produced 0.54/100 g soil of EA.

3.2.11. Exchangeable Cation Exchange Capacity (ECEC)

The result showed that there was significant difference when control was compared with the treatments and when the treatments were compared with one another. The sole humanure application produced 4.58 Cmol/kg when compared with control while the sole rumen digesta and humanure and rumen digesta combinations produced 3.78, 4.89, and 6.96 Cmol/kg respectively. When the sole rumen digesta application and humanure and rumen digesta combination of 10 + 10 t/ha were compared with the sole humanure application they produced 0.8 and 2.38 Cmol/kg respectively. The sole rumen digesta application produced 1.11 and 3.18 Cmol/kg when compared with humanure and rumen digesta combinations. The humanure and rumen digesta combinations of 5 = 5 and 10 + 10 t/ha produced 2.07 Cmol/kg when compared with one another. However, there was no significant difference when the sole humanure application was compared with the humanure and rumen digesta combination of 5 + 5 t/ha. This shows that with the addition of humanure and rumen digesta in the soil there is an increase in the exchangeable cation exchange capacity of the soil. This agrees with the NRCS (1996) which noted that organic matter retains nutrient by providing cation and anion exchange capacities.

3.2.12. Base Saturation (BS)

The result showed that there was significant difference when control was compared with the treatments and when the treatments were compared with one another. The sole humanure application produced 21.54 when compared with control while the sole rumen digesta and humanure and rumen digesta combinations produced 20.08, 22.23 and 28.02 respectively.

When the sole rumen digesta application and humanure and rumen digesta combination of 10 + 10t/ha were compared with the sole humanure application they produced 1.61 and 6.38 respectively. The sole rumen digesta application produced 2.2 and 7.99 when compared with humanure and rumen digesta combinations. The humanure and rumen digesta combinations of 5 = 5 and 10 + 10 t/ha produced 5.59 when compared with one another. However, there was no significant difference when the sole humanure application was compared with the humanure and rumen digesta combination of 5 + 5 t/ha.

3.3. Effects of Treatments on Cucumber Yield

The effects of humanure, rumen digesta, and humanure and rumen digesta combinations on cucumber yield is presented in Table 4.

Table 5: Effect of Treatments on Cucumber Yield.

Treatment	**Total yield(t/ha)**
Control	4.228[a]
H at 10t/ha	12.984[b]
RD at 10t/ha	27.280[c]
H and RD at 5+5t/ha	12.412[d]
H and RD at 10+10t/ha	10.512[e]
F-LSD(0.05)	28.4

Keys: H= Humanure, RD= Rumen Digesta. **Note:** Figures with the same super scripts are not statistically significant. 1.90

3.3.1. Total Yield

The result of the effect of treatment on cucumber total yield revealed that there was significant difference when yield from the control plot was compared with the treatments and when the treatments were compared with one another. The sole rumen digesta and humanure and rumen digesta combinations produced 8.75, 23.05, 8.18 and 6.28 $t.ha^{-1}$ respectively more cucumber fruit when compared with control. Further, the sole humanure application produced 14.29 $t.ha^{-1}$ less cucumber fruit than the sole rumen digesta application but produced 0.57 and 2.47 $t.ha^{-1}$ more cucumber fruits than T4 and T5 respectively. In addition there were 14.86 and 16.76 $t.ha^{-1}$ increases in cucumber fruit yield when the sole rumen digesta was compared with H and RD at 5+5 $t.ha^{-1}$ and H and RD at 10+10 $t.ha^{-1}$ combinations respectively. The H and RD at 5+5 $t.ha^{-1}$ proved superior to the H and RD at 10+10 $t.ha^{-1}$by recording more cucumber fruit yield of 1.90 $t.ha^{-1}$.

4.0. Conclusion

It was concluded that humanure and rumen digesta are good sources of organic manure for crop production since they improves soil physic-chemical properties significantly and increased yield of cucumber generally. The best nutrient source and rate in terms of soil improvement and yield was the sole rumen digesta application at the rate 10 $t.ha^{-1}$.

Recommendation

Farmers within and outside the environment are advised to make use of rumen digesta and humanure. This will not only help in improving the soil and crop yield but will also improve on the environment and prevent pollution. The residual effect should be to determine how long nutrients released from them can last in the soil.

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Table 3: Effects of Treatments on Soil Chemical Properties

Treatments	pH(H_20)	pH(Salt)	K(Coml./kg)	Na(Cmol/kg)	AVP(ppm)	N (%)	Ca(Cmol/kg)	Mg(Cmol/kg)	OM (%)	OC (%)	EA(Cmol/kg)	ECEC(Cmol/kg)	BS (%)
Control	4.7[a]	3.5[a]	0.088[a]	0.078[a]	20.3[a]	0.088[a]	2.35[a]	0.9[a]	1.49[a]	0.87[a]	1.4[a]	4.81[a]	70.95[a]
H at 10t/ha	5.5[b]	4.4[b]	0.2170[b]	0.117[b]	28.3[b]	0.143[b]	5.15[b]	3.2[b]	2.82[b]	1.63[b]	0.70[b]	9.39[b]	92.49[b]
RD at 10t/ha	5.3[c]	4.3[c]	0.2090[c]	0.112[c]	26.9[c]	0.141[c]	4.80[c]	2.7[c]	2.77[c]	1.61[c]	0.76[c]	8.59[c]	90.98[c]
H+RD at 5+5 t/ha	5.6[d]	4.4[d]	0.218[d]	0.121[d]	27.6[d]	0.144[d]	5.40[d]	3.3[d]	2.83[d]	1.64[d]	0.66[d]	9.7[d]	93.18[d]
H+RD at 10+10t/ha	12.7[e]	5.4[e]	0.304[e]	0.142[e]	40.6[e]	0.161[e]	6.70[e]	4.5[e]	3.44[e]	1.99[e]	0.12[e]	11.7[e]	98.97[e]
F-LSD$_{(0.05)}$	0.02	0.02	0.01	0.02	0.47	0.001	0.31	0.28	0.04	0.012	0.02	0.62	1.2

Keys: H= Humanure, RD= Rumen Digesta: **Note:** Figures with the same super scripts are not statistically significant while figures with different superscripts are significant.